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No-till soil and water issues
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Soil and water management

Many of the cultural practices used in crop production have huge effects on the soil, its structure and its biological life. Corrective crop management practices have focused primarily on the obvious "above ground" symptoms and problems. Research, however, has discovered that what appear to be subtle differences below the soil surface may have profound effects on productivity and sustainability. Producers must manage their tillage systems, crops, residues, and drainage systems to build healthier soils with improved structure to better manage their water resources. Improving soil structure and biological activity while maintaining residue cover will reduce runoff, erosion, evaporative losses, and the related environmental impacts.

Tillage concepts

Tillage of the soil has been used to prepare a seedbed, kill weeds, incorporate nutrients, and manage crop residues. The goal of the tillage system has been to provide a proper environment for seed germination and root growth for crop production. Throughout the years, tillage systems have changed as new technologies have become available and the costs of fuel and labor increased. With adoption of reduced tillage systems, many producers are realizing the negative effects of tillage as they see the soil and water conservation benefits of leaving the residue on the soil surface. No-till crop production systems leave the most residue and often prove to be the most profitable methods of crop production.

Soil structure

Soil is much more than the individual particles of sand, silt, and clay. A healthy soil is one where stable pores extend from the surface to deep into the soil profile. These pores allow water infiltration, root penetration, and air exchange to occur. While tillage has been used for crop production, it destroys soil structure, breaks up the soil pores, and reduces the amount of residue on the soil surface. If the soil structure was bad, e.g., compaction, this may be desirable as tillage can break up the compacted soil and create some new pores. However, if the soil structure was already favorable for crop growth, the tillage operation will break up the existing soil structure and make it more susceptible to compaction by reducing the soil's strength. Without soil structure, future operations may compact the soil by squeezing out the pore spaces between the soil aggregates. Without soil structure and pore spaces, infiltration and internal drainage decreases and problems with excess water arise, especially a lack of oxygen in the root zone. Ideally, the soil should be one-half solid materials (sand, silt, clay, nutrients, minerals, organic materials, and biological life) and one-half pore space (half of that containing water and the other half being air space).

Soil biological life

While tillage has been used to prepare a seedbed, it also destroys the existing root structures in the soil and some of the soil's biological life. The roots themselves are like rebar in concrete, giving the soil structural stability. The decaying roots provide channels for water penetration and new roots to grow in. The many fungi, bacteria, and other microorganisms in the soil system are the "glues" that hold individual soil particles together. They also process the roots and residue of the previous crops, cycling nutrients and carbon through the soil system. Larger organisms such as larva, bugs, and worms feed on the microorganisms further cycling materials in the soil and provide additional channels through the soil profile. Without this biological life, soil structure suffers and many of the nutrients are not as available for crop uptake.
Residue management
Crop residue absorbs raindrop impact and keeps the wind off the soil surface. This reduces soil particle detachment, reducing erosion from the forces of water and wind. By protecting the soil surface, crusting is also reduced, improving infiltration and decreasing runoff. This conserves soil and water and reduces risks to the environment. The residue mulch further conserves water by reducing evaporation from the soil surface. The decaying residue feeds the soil microbes and earthworms, cycling the nutrients and building soil structure. Crop residue must be properly managed year-round to provide the benefits and not interfere with crop production.

Water conservation
With improved soil structure and residue management, more water is available for crop production. Better infiltration allows more water to be stored in the soil profile rather than lost to runoff. However, depending on the soil moisture holding capacity of the soil, this improved infiltration may lead to leaching nutrients below the active crop rooting zone or losses out the drainage system. Producers must manage their crop selection to make efficient use of the water when it is available and, in some cases, intensify their cropping system to use the water that may be lost. Residue cover minimizes the exposure of the soil surface to wind and sunlight, reducing evaporation and keeping the soil surface cooler, often resulting in better rooting, especially near the soil surface. This makes the plant more efficient in using light rainfall events that don't soak far into the soil profile.

Excess water and cold soils
Wet soils take more heat energy to warm up than dry soils as the water must warm up as well. Likewise, warm wet soils take longer to cool off as the water holds heat. However, excess water can create problems with air exchange in the soil for crop root growth and soil biological activity. Some soils require drainage systems to get rid of excess water during certain times of the year. However, these soils may be dry in other times of the year. While drainage may be necessary, many producers prefer to build healthier soils that can store more water for use later in the season. By reducing crusting, improving soil structure, and increasing organic matter, no-till allows more water to be infiltrated and stored in the soil. When water can soak away from the soil surface internally, the soil can warm up faster. Unfortunately, some producers perform tillage to dry the soil, hoping to increase warming of the soil. While the soil does dry after the tillage, the drying continues all season long because of the tillage and the loss of residue. It is better to build soil structure and allow the water to soak deeper into the soil profile to be used later in the season, allowing the surface to warm. A key to success in no-till production systems is to avoid creating a mat of residue on the soil which reduces air movement down to the surface. In addition, cover crops can be used to “grow out” some of the excess water while feeding and building the soil system.

No-till is continuous no-till
No-till uses a systems approach to crop production where crops are grown with minimal soil disturbance and the soil is kept covered with crop residue to conserve soil and water. Continuous no-till and crop rotation, intensity, and diversity are keys to making no-till successful, building the soil system while minimizing potential problems. Too often, producers think that no-till is planting a crop one year without doing tillage. No, it's planting all the crops, every year, without tillage to get the full benefits of no-till. Residue management, crop rotation, nutrient management, integrated pest management, equipment and its proper operation, and many other cropping practices must be part of the systems approach. When no-till is properly managed, the soil structure and its biological life will improve; runoff, erosion, fuel use, and labor requirements will decrease; and infiltration, productivity, and profitability will increase. Without the systems approach, planting a crop without tillage will have problems and the producer will likely fail, blaming no-till, not the lack of management.